FIREBERD®

Operating Manual

CCITT G.704 2048 kb/s FRAMING INTERFACE (MODEL 30609) OPERATING MANUAL

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CCITT G.704 2048 kb/s FRAMING INTERFACE (MODEL 30609) OPERATING MANUAL

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GENERAL INFORMATION

1.1 INTRODUCTION

This manual contains information on Telecommunications Techniques Corporation's (TTC) CCITT G.704 2048 kb/s Framing Interface (Model 30609). This information is divided into sections on: general information; interface description, installation, and set-up; mainframe set-up; interface specifications; and service information.

1.2 OVERVIEW

The CCITT G.704 2048 kb/s Framing Interface allows a FIREBERD mainframe to test communications equipment and systems that conform with CCITT Recommendations G.703, G.704, and G.732.

1.3 INTERFACE FEATURES

The CCITT G.704 2048 kb/s Framing Interface has the following features.

- Recovers timing from the received signal, generates timing in the 2.048 MHz oscillator installed in the interface, or accepts timing from the FIREBERD mainframe.
- Accepts low-level degraded signals and regenerates the signal.
- Terminates or bridges a G.703/704/732 2048 kb/s circuit.
- Echoes all received data - code errors removed - to transmit output.
- Measures and generates jitter, when using the FIREBERD 6000 with Options 6007 and 6008.
- Accepts and generates framed or unframed data with a four-bit Cyclic Redundancy Code (CRC-4) error analysis and Time Slot 16 (TS-16) multiframe compatibility.
- Performs logic, code, framed word, and CRC-4 error analysis.
- Inserts programmable jitter and errors into the data stream in either Transmit or Thru Loop modes.
- Accepts High Density Bipolar Three (HDB3) or Alternate Mark Inversion (AMI) coding formats.
- Detects Alarm Indication Signal (AIS) and Yellow Alarm conditions.

1.4 INTERFACE COMPATIBILITY

The CCITT G.704 2048 kb/s Framing Interface is designed in accordance with and meets the following recommendations.

- CCITT G.703
- CCITT G.704
- CCITT G.732

1.5 OPTIONS AND ACCESSORIES

1.5.1 Cables

The following cables are available from TTC for the CCITT G.704 2048 kb/s Framing Interface.

- Model 30687, 10' cable with three-pin banana connector plug to three-pin banana.
- Model 30761, 10' cable with three-pin banana connector plug to bantam connector.

In addition to these cables, BNC connectors (widely available) may be used.

1.5.2 Model 11082 Monitor Adaptor

A Monitor Adaptor (Model 11082) is available for use with the CCITT G.704 2048 kb/s. Adding this adaptor allows the interface to be used in the North American 2.048 Mb/s environment without noticeable degradation of the monitored signal line. The adaptor "load" is contained in a BNC-type terminator, for connection to the 75-ohm UNBAL connector on the interface panel when the BRIDGE termination is selected. (Refer to Section 2 for more detail and further explanation of the controls and menu selections.) Since both input connectors (120-ohm and 75-ohm) are connected through an impedance transformer located inside the interface module, only one connector needs to be loaded to properly terminate the interface.

Monitor Adaptor Installation

The monitor adaptor is contained in a BNC-type connector that is attached to the interface panel by a chain. This type of attachment allows the adaptor to be connected or disconnected, as required. Perform the following steps to attach the monitor adaptor to the interface panel.

(1) Turn the interface panel facing toward you.

(2) Remove the Phillips head screw at the right side of the interface panel.

(3) Insert the removed screw through the eyelet on the adaptor chain and secure the chain to the interface panel by screwing the screw into the interface panel.

This completes the installation of the adaptor to the interface. Refer to the application section for examples of how and when to use the adaptor.

Monitor Adaptor Theory of Operation

When the CCITT G.704 2048 kb/s Framing Interface is used for monitoring a span line, internal automatic line build-out compensates for high frequency losses by providing increased high frequency gain. By compensating for cable losses, the signal is restored, allowing the digital information to be recovered.

When using the FIREBERD at a monitor access point (DSX Monitor), the signal attenuation is the result of resistive attenuation, introduced by the monitor access point connection, rather than the result of cable loss. The monitor adaptor is designed to compensate for this type of reduction in signal amplitude.

Monitor Adaptor Application

Connecting the monitor adaptor to the 75-ohm (unbalanced) RECEIVER connector allows the 120-ohm (balanced) banana connectors to be used for the purposes of monitoring. This allows the banana connectors to be plugged into the monitor access point when the interface is in the BRIDGE operating mode. The monitor adaptor compensates for the resistive attenuation of the monitored signal, preventing errors in signal detection.

The monitor adaptor helps to prevent erroneous detection of BPVs and logic errors caused when the signal attenuation is not due to cable loss. This condition is most noticeable when the interface is used to bridge across a monitor access port. Installing the monitor adaptor changes the signal shape to simulate cable loss, allowing more accurate BPV and logic error detection.

If the 75-ohm connector is to be used for monitoring, a BNC-type "T" connector should be used to allow both the termination necessary and the attachment to the line being monitored.

The monitor adaptor is typically used when the interface termination is set to BRIDGE. When operating without resistive attenuation, it is recommended that the monitor adaptor be disconnected. Table 1-1 provides this information in tabular form for quick reference during different modes of testing.

Table 1-1
Monitor Adaptor Recommended Usage

LINE* Selection	Test Conditions	Monitor Adaptor	Terminating Resistance
TERM	At the end of a line or cable	Disconnected	75- or 120-ohm
BRIDGE	Any place along span line that is already terminated	Disconnected	Unterminated
BRIDGE (MONITOR)	Connected to a 120-ohm monitor access port	Connected	120-ohm
BRIDGE (MONITOR)	Connected to a 75-ohm monitor access port	Connected by a BNC "T" adaptor	75-ohm

* Selected through the CCITT G.704 2048 kb/s interface menu in the FIREBERD.

INTERFACE DESCRIPTION

2.1 INTRODUCTION

The CCITT G.704 2048 kb/s Framing Interface is a menu-controlled interface. This section describes the interface connectors, the interface functions, the timing sources, and the self-loop test.

2.2 PHYSICAL DESCRIPTION

The CCITT G.704 2048 kb/s Framing Interface measures 7.3 inches (185 mm) wide, 1.5 inches (38 mm) high, and 5.1 inches (130 mm) deep. Two spring-tensioned screws secure the interface module to the FIREBERD Communications Analyzer rear panel. Connector pins on the interface module mate with the mainframe's connector receptacle when the interface panel is flush with the mainframe rear panel.

Depending on the line impedance (75-ohm or 120-ohm), either BNC or banana connectors are used to provide the input and output connections for this interface. Figure 2-1 illustrates the CCITT G.704 2048 kb/s Framing Interface front panel. Banana connectors provide the 120-ohm balanced transmitter and receiver inputs. BNC connectors are provided for the 75-ohm unbalanced input and output connections.

NOTE: When using this interface in a North American standard environment, TTC recommends attaching the Monitor Adaptor (Model 11082) when connected to a monitor access point and operating in the BRIDGE mode.

Four toggle switches are located on the interface front panel. When this interface is installed in the FIREBERD 6000 and FIREBERD 4000, all of these switches are under mainframe control and can be set and reset by the FIREBERD front panel switches. The following paragraphs describe these interface controls.

MODE Switch - This two-position toggle switch selects either the framed (FRAME) or the unframed (UNFRAME) mode of operation. In the FRAME position, the interface transmits and expects to receive G.704 framed data. With this toggle switch in the FRAME position, CRC-4 or TS-16 multiframing are enabled, if the DIP switch segments (segments 2 and 3) are set to the CLOSED position. With this switch set to the UNFRAME position, the interface transmits and expects to receive unframed data at a rate of 2.048 Mb/s.

CLOCK Switch - This two-position toggle switch selects the source of the timing clock. In the XTAL (crystal) position, the crystal oscillator on the interface becomes the transmit timing source. Setting this switch to the RECOV (recovered) position, the interface uses the clock recovered from the incoming G.704 data as the transmit timing source.

LINE Switch - This two-position toggle switch controls the interface input impedance. When this switch is set to the TERM position, the interface input impedance is either 75 ohms or 120 ohms. The input impedance is determined by which connector (120-ohm balanced or

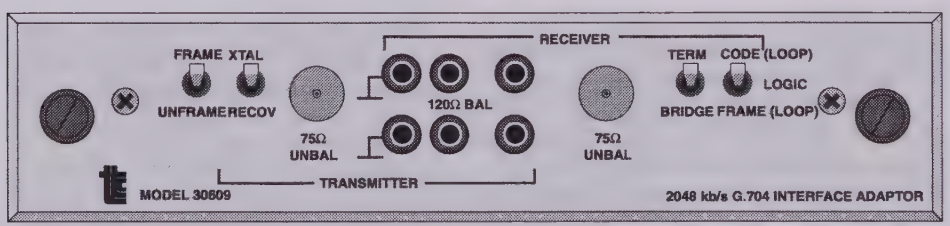

Figure 2-1
CCITT G.704 2048 kb/s Framing Interface

75-ohm unbalanced) is used as the interface input. With this toggle switch set to the BRIDGE position, the interface input impedance is 1000 ohms or greater.

ANALYSIS Switch - This three-position toggle switch determines the type of error analysis the interface performs. With this toggle switch set to the CODE (LOOP) position, the received data is looped back to the transmitter. In the LOGIC position, the received data has the frame bits stripped (during the FRAME mode). The remaining data is sent to the FIREBERD for analysis. In the FRAME (LOOP) position, the received data is looped back to the transmitter.

NOTE: When the Analysis switch is set to either the CODE (LOOP) position or the FRAME (LOOP) position, received data is looped back through the interface First In/First Out (FIFO) buffer. Therefore, the CLOCK switch should be set to the RECOV position and the interface should be selected as the transmit timing source by the FIREBERD.

2.3 DIP SWITCH SETTINGS

A four segment DIP switch (S5) is located on the interface printed circuit (PC) board. Each DIP switch segment (1-4) controls a separate interface function. These functions are: code, CRC-4, time slot 16 multiframe, and receiver earth. All of these DIP switch settings, with the exception of receiver earth, are controllable by the mainframe front panel controls.

The following paragraphs describe the DIP switch segments and the functions controlled by each segment.

CODE SELECTION - DIP switch segment 1 allows selection of either HDB3 or AMI coding. With this switch segment set to OPEN, HDB3 coding is selected. Setting this switch segment CLOSED selects AMI coding. This switch segment is preset to OPEN.

CRC-4 SELECTION - DIP switch segment 2 enables or disables the CRC-4 generator. With this switch segment set to OPEN, the CRC-4 generator is disabled and pulses are inserted into the unused frame positions. With this switch segment set to CLOSED, CRC-4 bit transmission is enabled. It also causes the receiver to search for CRC-4 multiframe synchronization. This switch segment is preset to CLOSED.

TIME SLOT 16 SELECTION - DIP switch segment 3 enables or disables the Time Slot 16 (TS-16) multiframing. With this switch segment set to OPEN, the TS-16 multiframe function is disabled. Setting this switch segment to CLOSED enables the transmission of TS-16 multiframes and causes the receiver to search for multiframe synchronization. TS-16 multiframed data is transmitted with signaling bits set to all 1's. This switch segment is preset to CLOSED.

RECEIVER EARTH SELECTION - DIP switch segment 4 enables or disables the receiver cable shield as earth ground. With this switch segment set to OPEN, the receiver BNC cable shield is isolated from earth ground. In the CLOSED segment, the connector shield is tied to earth ground. This switch segment is preset to OPEN.

NOTE: This DIP switch segment is not controllable from the FIREBERD mainframe front panel.

2.4 FUNCTIONAL DESCRIPTION

The CCITT G.704 2048 kb/s Framing Interface allows the FIREBERD Communications Analyzer to test communications systems which conform to the 2.048 Mb/s digital channel service and other similar systems. This interface operates with either framed data, as required by Digital Access Crossconnect Switches (DACS) and channel banks, or with unframed data, as used in unswitched networks.

2.4.1 Error Analysis

This interface features four types of error analysis:

- Logic error analysis.
- Code violation analysis.
- Frame word error analysis.
- CRC-4 error analysis.

During error analysis, frame bits are stripped from received data (during Framed operating mode). The data content of the received signal is then sent to the FIREBERD for bit error analysis. During code violation analysis, the interface searches for (HDB3 or AMI code violations. During frame word error analysis, the bits of the frame alignment signal are analyzed and errors are detected. During CRC-4 error analysis, blocks of data are analyzed, with the CRC remainder compared to the CRC found in the received data.

2.4.2 Framing

The 2048 kb/s G.704 Framing Interface operates in either framed or unframed modes. In the unframed mode, the interface transmits and receives unframed data at the rate of 2.048 Mb/s. No framing information is provided; the entire signal bandwidth is used for data. In the framed mode, the

interface transmits and receives data with framing information. Table 2-1 depicts the allocation of bits 1 through 8 of the Time Slot 0 (TS-0) that conveys the framing information.

During the framed mode of operation, Time Slot 16 (TS-16) multiframing may either be enabled or disabled. With TS-16 enabled, the data contents of the signal occupies 30 time slots (TS-1 through TS-15 and TS-17 through TS-31), for a 1.920 Mb/s data content. Disabling TS-16 multiframing configures the signal data content to occupy 31 time slots (TS-1 through TS-31), for a 1.984 Mb/s data content. Table 2-2 depicts the bit allocation of channel Time Slot 16.

Table 2-1
Time Slot 0 Bit Allocations

Framed Mode

Alternate frames \ Bit Number	1	2	3	4	5	6	7	8
Frame containing the frame alignment signal	S_i	0	0	1	1	0	1	1
		Frame alignment signal						
Frame not containing the frame alignment signal	S_i	1	A	S_n	S_n	S_n	S_n	S_n

S_i - Bits reserved for international use. Fixed at 1 when not in use.
A - Remote alarm indication. In undisturbed operation, 0: in an alarm condition, 1.
S_n - Spare bits reserved for national use. Not used on receiver, fixed at 1 on transmitter.

Table 2-2
Bit Allocation of Channel Time Slot 16

Channel time slot 16 of frame 0	Channel time slot 16 of frames 1 to 15
0000 xyxx	1111 1111

x = spare bit not used on receiver, fixed at 1 on transmitter.
y = bit used to indicate loss of multiframe alignment.

Also during the framed mode of operation, CRC-4 multiframing may either be enabled or disabled. When CRC-4 multiframing is enabled, the FIREBERD transmits and expects to receive CRC-4 information in bit 1 of TS-0. Disabling CRC-4 multiframing sets bit 1 of TS-0 to a "1". Table 2-3 depicts the CRC-4 multiframe structure.

2.4.3 Timing Sources

For the FIREBERD 6000, four transmit timing sources can be selected: (1) the clock recovered by the interface from the incoming G.704 signal; (2) the synthesizer clock, which can provide an internal timing reference at or around 2.048 MHz; (3) the external BNC input, or (4) the interface crystal oscillator. Selection of the timing source on the FIREBERD 6000 is made by pressing the front panel pushbutton switch labeled GEN CLK. Repeatedly pressing this pushbutton scrolls through its three selections (SYNTH, INTF, or BNC).

Selection of the timing source on the FIREBERD 4000 is made by pressing the SETUP CATEGORY rocker switch until the LED next to the GENERATOR CLOCK label is illuminated. The three softkey pushbutton switches above the SETUP panel are used to select the INTRNL, INTF, or BNC timing source.

2.4.4 Self-Loop

This data interface includes a relay that is activated by the SELF LOOP pushbutton switch on the FIREBERD front panel. Pressing the SELF LOOP pushbutton switch connects the primary 2MG704 driver to the line receiver. This provides quick verification of the FIREBERD and the data interface when performing bit error detection.

NOTE: Do not set the generator clock (GEN CLK pushbutton switch on the FIREBERD 6000 or GENERATOR CLOCK on the FIREBERD 4000) to the INTF or INTRNL position during the Self-Loop mode and be sure the THRU LOOPBACK menu is set to OFF.

Table 2-3
CRC-4 Multiframe Structure

	Sub-multiframe (SMF)	Frame Number	Bits 1 to 8 of the frame							
			1	2	3	4	5	6	7	8
Multiframe	I	0	C_1	0	0	1	1	0	1	1
		1	0	1	A	S_n	S_n	S_n	S_n	S_n
		2	C_2	0	0	1	1	0	1	1
		3	0	1	A	S_n	S_n	S_n	S_n	S_n
		4	C_3	0	0	1	1	0	1	1
		5	1	1	A	S_n	S_n	S_n	S_n	S_n
		6	C_4	0	0	1	1	0	1	1
		7	0	1	A	S_n	S_n	S_n	S_n	S_n
	II	8	C_1	0	0	1	1	0	1	1
		9	1	1	A	S_n	S_n	S_n	S_n	S_n
		10	C_2	0	0	1	1	0	1	1
		11	1	1	A	S_n	S_n	S_n	S_n	S_n
		12	C_3	0	0	1	1	0	1	1
		13	S_i*	1	A	S_n	S_n	S_n	S_n	S_n
		14	C_4	0	0	1	1	0	1	1
		15	S_i*	1	A	S_n	S_n	S_n	S_n	S_n

S_i*: Spare bits for international use. Not used on receiver, fixed at 1 on transmitter.
S_n: Spare bits reserved for national use. Not used on receiver, fixed at 1 on transmitter.
C_1, C_2, C_3, C_4: Cyclic Redundancy Check (CRC) bits.
A: Remote alarm indication.

INTERFACE INSTALLATION, SET-UP, AND OPERATION

3.1 INTRODUCTION

This section is divided into two major parts. Each part describes the interface installation, set-up, and operating procedures for the FIREBERD 6000 and FIREBERD 4000 mainframes, respectively. Refer to the appropriate FIREBERD mainframe User's Guide and Operating Manual for mainframe operating procedures and for additional information.

3.2 FIREBERD 6000

The following sections describe installation, set-up, and operation of this interface for a FIREBERD 6000 mainframe.

3.2.1 Interface Installation

The following procedure describes the steps for installing the interface in a FIREBERD 6000.

CAUTION: Turn the AC power OFF before installing the interface module in the FIREBERD mainframe.

(1) Ensure that the POWER switch is in the OFF position on the FIREBERD mainframe front panel.

(2) Turn the FIREBERD mainframe around to expose the rear panel interface slot.

(3) Insert the interface module into the vacant interface slot, with the PC board facing up. The PC board edges fit into slides on either side at the top edges of the interface slot.

(4) Press the interface module firmly into the mainframe mating connector, until the interface faceplate is flush with the mainframe rear panel.

(5) Secure the interface in the mainframe by turning the two screws on the interface front panel clockwise, until finger tight.

3.2.2 FIREBERD 6000 Mainframe Set-Up

The following steps outline the procedure for setting up the FIREBERD 6000 mainframe after the interface installation is complete.

(1) With the CCITT G.704 2048 kb/s Framing Interface installed, turn the AC power on by pressing the front panel POWER switch to the ON position.

(2) Connect the G.704 signal source to the desired interface panel RECEIVER connector.

(3) Press the DATA pushbutton switch to select the desired data pattern. A data pattern is selected when the LED is illuminated next to the data pattern label. Refer to the FIREBERD 6000 User's Guide for a description of the different data patterns available and their uses.

(4) Press the GEN CLK pushbutton switch to select the signal timing source (2048) for use during the test. Selecting a signal timing source other than SYNTH requires an external clock source from either the network or another source.

(5) Setting the TIMING MODE is not necessary with the CCITT G.704 2048 kb/s Framing Interface installed.

(6) Press the MENU pushbutton to illuminate the LED next to the INTF SETUP label. The message: **INTERFACE: XXXXXX** is displayed on the top line and a list of available interfaces is displayed on the bottom line.

(7) Press the 2MG704 softkey to select the CCITT G.704 2048 kb/s Framing Interface. Pressing this softkey displays **INTERFACE: 2MG704** on the top line and the first three menu selections (**FRAME, RESULT,** and **ERRINS**) on the bottom line.

(8) Once the desired menu parameter is visible in the display, press the corresponding softkey to change the interface operating parameter. Refer to Section 3.2.3 for a description of the menus and selections available.

(9) After the interface parameters are set as desired, press the ENTER key to display the interface top level menu (**INTERFACE: 2MG704**), or press the up arrow key and then press the corresponding softkey to enter another menu.

(10) Press the MENU pushbutton switch to select other criteria required for the test to be performed.

(11) Set the other front panel controls (ANALYSIS RESULTS, ANALYSIS MODE, PRINTER, etc.) as required for the test to be performed.

(12) Press the SELF LOOP pushbutton switch to perform the self-test on the mainframe and installed interface.

3.2.3 Interface Set-Up

This section describes the interface selections available for the FIREBERD 6000, after the mainframe has been configured. The CCITT G.704 2048 kb/s Framing Interface is selected through the FIREBERD 6000 front panel controls. Control of the interface may be either by the FIREBERD front panel or by the interface front panel controls.

Once in the 2MG704 interface menu, pressing the up arrow key displays the next higher menu level. Pressing the ENTER key displays the interface selection menu top level. Figure 3-1 illustrates the CCITT G.704 2048 kb/s Framing Interface menu.

The following paragraphs list each menu, along with a description of the selections available.

FRAMING

UNFRAM - Selects the unframed data format. Unframed data is transmitted at a rate to 2.048 Mb/s and the FIREBERD expects to receive unframed data at the same rate.

FRAME - Selects the framed data format. In this mode, G.704 framed data is transmitted and is expected to be received. When the FRAME softkey is pressed, two additional menus are visible on the display. These two selections are CRC4 and TS16. CRC4 is a cyclic redundancy check comprising 16 frames that is used to calculate the check sum. This value is imbedded in the next frame for the purpose of error correction. TS16 is the channel time slot that is allotted for the purposes of signaling.

RESULTS MODE

STD - Selects standard analysis results. Bit error, bipolar violation (BPV), framing error, and CRC error analysis are performed. When synchronization and frame losses are detected, framing error and CRC4 analysis are not performed. Framing error analysis is only performed when STD and FRAME have been selected, respectively, from the FRAME and RESULT menus. CRC4 error analysis is only performed when this selection is combined with the CRC4 selection from the FRAME menu. The results from standard testing are based on the time interval that the FIREBERD has maintained pattern and frame (if applicable) synchronization. All of the FIREBERD test measurements are available using standard test results. **NOTE:** When this menu option is selected, the THRU LOOPBACK menu should be set to OFF.

LIVE - Selects live traffic analysis results. Live test results are based on the time interval that signal and frame synchronization (if applicable) are present. All FIREBERD test measurements, except for bit error analysis, are available using live test results. CRC error analysis is only performed when the LIVE selection is combined with the CRC4 menu selection from the FRAME menu. Live testing is recommended for applications where framing or BPV error analysis is being performed on in-service circuits.

NOTE: When this menu item is selected, the TLB menu should be set to ON.

ERROR INSERT

OFF - Does not insert any errors into the transmitted data.

SINGLE - Inserts a single bit error into the transmitted data after framing and line encoding have been performed. Inserted errors cause logic errors, code (BPV) errors, and may cause frame word errors and CRC-4 errors. If HDB3 coding is selected (from the CODE menu), error multiplication may also occur. After the error bit has been transmitted, the error insert menu displays **OFF**. **NOTE**: To generate accurate error insertion rates, the FIREBERD frequency synthesizer must be set to 2048 kHz, even if the synthesizer is not used as the source of transmit timing.

Figure 3-1
FIREBERD 6000 CCITT G.704 2048 kb/s Framing Interface Menu

RATE - Inserts errors on the transmit signal at selectable error rates after framing and line encoding have been performed. Inserted errors cause logic errors, code (BPV) errors, and may cause frame word errors and CRC-4 errors. If HDB3 coding is selected (from the CODE menu), error multiplication may also occur.

Selection of the error insertion rate is operator selectable for the FIREBERD 6000 and is controlled by pressing the RATE softkey. This positions the cursor under the mantissa (the first digit) and HELP is displayed on the bottom line. Pressing the corresponding HELP softkey displays the message **Enter code error rate. Rates: 1E-9 to 9E-3** and places the cursor under the mantissa. Using the keypad keys (1-9), a new value may be entered. Pressing the desired value moves the cursor under the exponent and **SET ERR RATE:** is visible in the display. Pressing the ENTER key at this stage moves the cursor back to the mantissa, if the entered value was not correct or needs to be changed. Use the keypad keys (3 - 9) to select the new rate desired. Entering an out-of-tolerance value and then pressing the ENTER key produces an audio tone and redisplays the last valid insertion rate. The new rate is not selected until the ENTER key is pressed. Until the ENTER key is pressed, the errors are transmitted at the previously displayed rate. Pressing the ENTER key changes the error rate to the new rate and redisplays the top level menu for the interface selection.

NOTE: To ensure accurate insertion rates, the synthesizer frequency must be set to 2048 kHz. Any other setting causes inaccurate insertion rates.

THRU LOOPBACK

OFF - Disables the thru-loopback. This establishes the FIREBERD as the source of the transmitted data.

ON - Applies the received data to the interface FIFO buffer. This data is then clocked out by the transmit clock and applied to the TRANSMITTER connector. With the THRU LOOPBACK menu ON, this interface can act as a monitor for code, frame word, and CRC-4 errors. In addition, jitter and either single or variable error rates can be inserted into the data stream. Looped-back data is either AMI- or HDB3-decoded before being re-encoded for transmission to remove code violations from the thru-data.

CODE

AMI - Allows Alternate Mark Inversion (AMI) coding. AMI is encoded by transmitting a pulse of alternating polarity for each one (Mark) and no pulse for each zero (Space).

HDB3 - Allows High Density Bipolar Three (HDB3) coding. This code substitutes ones and zeros for binary strings containing more than three consecutive zeros. In HDB3, the second and third zeros of a zero string are unchanged. However, the fourth zero is transmitted with the same polarity as the preceding one (Mark). This is a violation of the bipolar AMI format. The HDB3 decoder restores a detected HDB3 pattern to the original four zeros.

CLOCK

XTAL - Selects the FIREBERD as the clock reference transmit timing source. This selects the interface crystal oscillator as the transmit timing source when GEN CLK is set to INTF.

RECOV - Disables the FIREBERD as the transmit timing source and recovers the clock from the incoming G.704 data as the transmit timing source when GEN CLK is set to INTF.

LINE

TERM - Terminates the monitored line with either 75 ohms or 120 ohms. This function is selected when the FIREBERD is used to terminate a span line. Depending on the impedance of the line, either the BAL 120-ohm connectors or the UNBAL 75-ohm connectors are used.

BRIDGE - Provides a minimum of 1000 ohms input impedance. This function is selected when the FIREBERD is monitoring a span line to prevent unnecessary loading of the signal being monitored.

NOTE: When the LINE menu is set to BRIDGE and the FIREBERD is connected to a monitor access point, connecting the Monitor Adaptor is recommended. Refer to section 1.5.2 for more information on the Monitor Adaptor.

3.2.5 FIREBERD 6000 Interface Remote Control

Using the built-in RS-232 interface or the optional IEEE-488 interface, the FIREBERD 6000 mainframe can be remotely controlled. The Remote Control Commands Handbook describes the mainframe remote control capabilities.

Only the remote control commands specific to this interface are included in Table 3-1. Also note that these commands are used with a FIREBERD 6000 with at least Revision G

Table 3-1
FIREBERD 6000 G.704 2048 kb/s Data Interface Remote Commands

Remote Command	Result
INTF:2MG704:FRAMING?	Displays the framing.
INTF:2MG704:FRAMING OFF	Selects the unframed mode.
INTF:2MG704:FRAMING ON	Selects the framed mode.
INTF:2MG704:FRAMING:CRC4?	Displays the status of the CRC-4 multiframe option.
INTF:2MG704:FRAMING:CRC4 OFF	Disables the CRC-4 multiframe option.
INTF:2MG704:FRAMING:CRC4 ON	Enables the CRC-4 multiframe option.
INTF:2MG704:FRAMING:TS16?	Displays the status of the TS-16 multiframe option.
INTF:2MG704:FRAMING:TS16 OFF	Disables the TS-16 multiframe option.
INTF:2MG704:FRAMING:TS16 ON	Enables the TS-16 multiframe option.
INTF:2MG704:RESULT_MODE?	Displays the result mode.
INTF:2MG704:RESULT_MODE STD	Selects the standard results mode.
INTF:2MG704:RESULT_MODE LIVE	Selects the live results mode.
INTF:2MG704:THRU_MODE?	Displays the status of the thru-loopback mode.
INTF:2MG704:THRU_MODE OFF	Disables the thru-loopback mode.
INTF:2MG704:THRU_MODE ON	Enables the thru-loopback mode.
INTF:2MG704:ERR_INSERT?	Displays the error insertion mode.
INTF:2MG704:ERR_INSERT OFF	Disables error insertion mode.
INTF:2MG704:ERR_INSERT SINGLE	Selects the single error insertion mode.
INTF:2MG704:ERR_INSERT RATE	Selects the operator-specified error insertion mode.
INTF:2MG704:ERR_RATE?	Displays the operator-specified error insertion rate.
INTF:2MG704:ERR_RATE (rate string)	Selects the operator-specified error insertion rate (xE-y, where x = 1 to 9 and y = 3 to 9).
INTF:2MG704:INPUT?	Displays the interface input impedance.
INTF:2MG704:INPUT TERM	Selects the 75-ohm or 120-ohm interface input impedance.
INTF:2MG704:INPUT BRIDGE	Selects the 1000-ohm interface input impedance.
INTF:2MG704:CODING?	Displays the coding.
INTF:2MG704:CODING AMI	Selects AMI coding.
INTF:2MG704:CODING HDB3	Selects HDB3 coding.
INTF:2MG704:TIMING?	Displays the transmit timing reference.
INTF:2MG704:TIMING XTAL	Selects the interface crystal oscillator as the transmit timing reference.
INTF:2MG704:TIMING RECOV	Selects the recovered timing mode as the transmit timing reference.

software. Remote control commands that support Revision F software or lower are contained in Appendix A of this manual.

If the CCITT G.704 2048 kb/s interface is installed in the FIREBERD 6000's rear panel, issue the following command prior to using the commands listed in Table 3-1:

>INTF:SELECT EXT

If the CCITT G.704 2048 kb/s interface is installed in an ISU-6000, specify the ISU and slot numbers as follows:

>INTF:SELECT:ISU 1,3

EXAMPLE: The CCITT G.704 2048 interface is in ISU #1, Slot #3.

3.2.6 Notes

The following section lists information which should be helpful when using the G.704 2048 kb/s Framing Interface with the FIREBERD 6000.

(1) All data extracted from the FIREBERD is inverted prior to transmission. This means, for example, that an all-ones pattern is transmitted as all spaces and vice-versa. This inversion can be negated by setting the Auxiliary Function 06 (GEN DATA INV) to ON.

(2) The FIREBERD's 2^{20}-1 pattern follows a North American specification and is not compatible with the 2^{20}-1 pattern specified in CCITT Recommendation V.57.

(3) While the G.704 2048 kb/s Framing Interface may be operated under interface control (as opposed to FIREBERD menu control), TTC does not recommend setting Auxiliary Function 05 (Interface Control) to INTF. For maximum flexibility and control of the interface, TTC recommends keeping Auxiliary Function 05 set to F-BERD.

(4) In order to generate accurate error insertion rates, the FIREBERD frequency synthesizer must be set to 2048 kHz, even if the synthesizer is not used as the source of transmit timing.

(5) Various LEDs on the FIREBERD 6000 indicate specific operating and alarm conditions, as follows:

LED Name:	Condition:
FRM SYNC	Frame Synchronization
ALM 1	Yellow Alarm
ALM 2	AIS

3.3 FIREBERD 4000

The following sections describe the installation, set-up, and operation of this interface in a FIREBERD 4000 mainframe.

3.3.1 Interface Installation

The following procedure describes the steps for installing the interface in a FIREBERD 4000 mainframe.

CAUTION: Turn the AC power OFF before installing the interface module in the FIREBERD mainframe.

(1) Ensure that the POWER switch, located on the rear panel, is in the OFF position on the FIREBERD mainframe.

(2) Turn the FIREBERD mainframe around to expose the rear panel interface slot(s). The FIREBERD 4000 may have two interface slots, if Option 4001 (optional interface) is installed. Slot 1 (the bottom slot) is standard and Slot 2 (the top slot) is optional.

(3) Insert the interface module into the vacant interface slot, with the PC board facing up. The PC board edges fit into slides in either side at the top edges of the interface slot.

(4) Press the interface module firmly into the mainframe mating connector, until the interface faceplate is flush with the mainframe rear panel.

(5) Secure the interface in the mainframe by turning the two screws on the interface front panel clockwise, until finger tight.

3.3.2 FIREBERD 4000 Mainframe Set-Up

The following steps outline the procedure for setting up the FIREBERD 4000 mainframe after the interface installation is complete.

(1) With the CCITT G.704 2048 kb/s Framing Interface installed, turn the AC power on by pressing the rear panel POWER switch to the ON position.

(2) Connect the G.704 signal source to the rear panel RECEIVER connector desired.

(3) Press the SETUP CATEGORY rocker switch to illuminate the LED next to the PATTERN label. The first three data pattern choices are visible on the bottom line of the display. Pressing the MORE pushbutton switch displays additional data patterns. The selected data pattern is visible after **PATTERN:** in the display. Refer to the FIREBERD 4000 User's Guide for a description of the different data patterns available and their uses.

(4) Press the SETUP CATEGORY rocker switch to illuminate the LED next to the label GENERATOR CLOCK to select the signal timing source for use during the test.

(5) The front panel displays **GEN CLOCK: XXXXXX** on the top line and the three choices on the bottom line. Selecting the BNC signal timing source requires an external clock source from either the network or another source.

NOTE: The 2048 kHz internal frequency is automatically selected when the CCITT G.704 2048 kb/s Framing Interface is selected.

(6) Press the SETUP CATEGORY rocker switch to illuminate the LED next to the INTERFACE label. The message: **INTERFACE: XXXXXX** is displayed on the top line and a list of available interfaces is displayed on the bottom line.

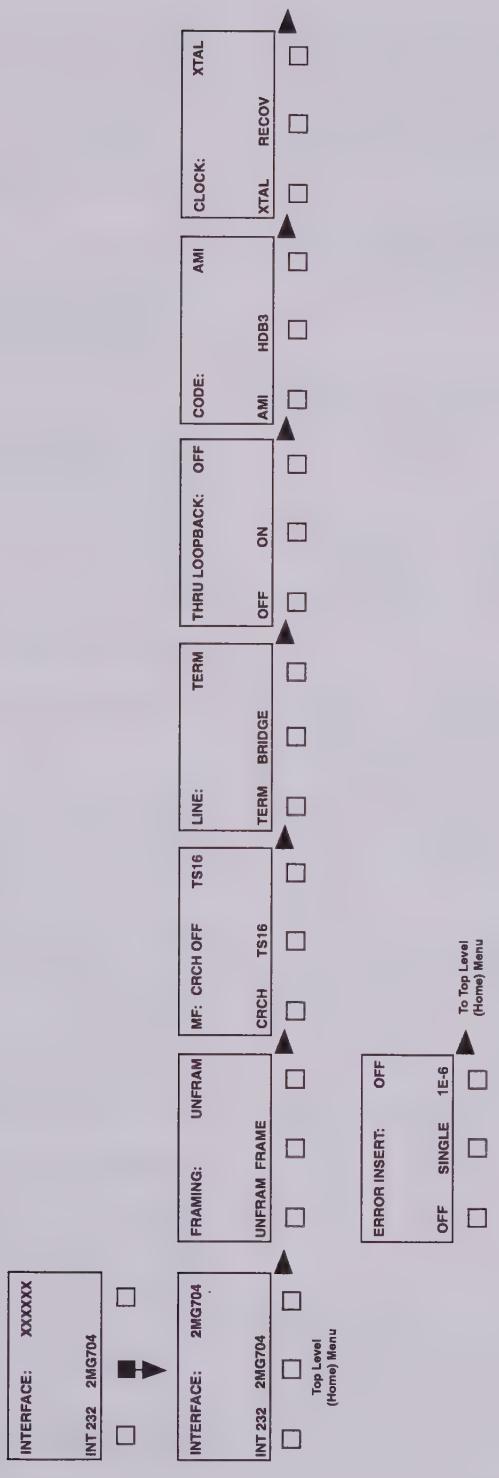

Figure 3-2
FIREBERD 4000 CCITT G.704 2048 kb/s Framing Interface Menu

NOTE: If FRAMING is set to UNFRAMED, the MF (Multiframe) menu is not visible.

(7) Press the 2MG704 softkey to select the CCITT G.704 2048 kb/s Framing Interface. Pressing this softkey displays: **INTERFACE: 2MG704** on the top line. Pressing the right SETUP SELECT switch allows the first menu of this interface to be displayed. Repeatedly pressing the SETUP SELECT switch scrolls through the menus and back to the top level interface menu. Refer to Figure 3-2 for the FIREBERD 4000 CCITT G.704 2048 kb/s Framing Interface menu.

(8) Once the desired menu parameter is visible in the display, press the corresponding softkey to change the interface operating parameter. Refer to Section 3.3.3 for the menus and selections available.

(9) After the interface parameter is set as desired, press the HOME key to display the interface top level menu (**INTERFACE: 2MG704**) or continue pressing the SETUP SELECT switch to continue through the other interface parameters.

(10) Press the SETUP CATEGORY rocker switch to set or verify other criteria required for the test that is to be performed. Pressing the SETUP CATEGORY rocker switch to illuminate the LED next to the SETUP SUMMARY label displays the selected test pattern, interface, clock frequency, and the two most significant interface parameters.

(11) Set the other front panel controls (RESULT SELECT, CATEGORY, PRINTER, etc.) as required to configure the mainframe for the test to be performed. The SETUP SUMMARY may be used to quickly view the mainframe set-up parameters.

(12) Press the SELF LOOP pushbutton switch to perform the self-test on the mainframe and installed interface.

3.3.3 Interface Set-Up

This section describes the interface selections available for the FIREBERD 4000, after the mainframe has been configured. The CCITT G.704 2048 kb/s Data Interface is selected and controlled by the FIREBERD 4000 front panel controls.

The following paragraphs describe the interface menu options and menu selections. Each menu is listed, along with a description of the selections available. Figure 3-2 illustrates the FIREBERD 4000 CCITT G.704 2048 kb/s Framing Interface menu.

FRAMING

UNFRAM - Selects the unframed data format. Unframed data is transmitted at a rate to 2.048 Mb/s and the FIREBERD also expects to receive unframed data at the same rate. With UNFRAM selected the MF (Multiframe) menu is not displayed.

FRAMED - Selects the framed data format. In this mode, G.704 framed data is transmitted and is expected to be received. When the FRAME softkey is pressed, two additional menus are visible in the display. These two selections are CRC-4 and TS-16. CRC4 is a cyclic redundancy check comprising 16 frames that is used to calculate the check sum. This value is embedded in the next frame for the purpose of error correction. TS-16 is the channel time slot that is allotted for the purposes of signaling.

MF

CRC4 - Toggles the CRC-4 menu between OFF and ON.

TS16 - Toggles the TS-16 menu between OFF and ON.

LINE

TERM - Terminates the monitored line with either 75 ohms or 120 ohms. This function is selected when the FIREBERD is used to terminate a span line. Depending on the impedance of the line, either the BAL 120-ohm connectors or the UNBAL 75-ohm connectors are used.

BRIDGE - Provides a minimum of 1000 ohms input impedance. This function is selected when the FIREBERD is monitoring a span line to prevent unnecessary loading of the signal being monitored.

NOTE: When the LINE menu is set to BRIDGE and the FIREBERD is connected to a monitor access point, connecting the Monitor Adaptor is recommended. Refer to section 1.5. for more information on the Monitor Adaptor.

THRU LOOPBACK

OFF - Disables the thru-loopback. This establishes the FIREBERD as the source of the transmitted data.

ON - Applies the received data to the interface FIFO buffer. This data is then clocked out by the transmit clock and applied to the TRANSMITTER connector. With the THRU LOOPBACK menu category ON, this interface can act as a monitor for code, frame word, and CRC-4

errors. In addition, single or fixed error rates can be inserted into the data stream. Looped-back data is first AMI- or HDB3-decoded before being re-encoded for transmission to remove code violations from the thru-data.

CODE

AMI - Allows Alternate Mark Inversion (AMI) coding. AMI is encoded by transmitting a pulse of alternating polarity for each one (Mark) and no pulse for each zero (Space).

HDB3 - Allows High Density Bipolar Three (HDB3) coding. This code substitutes ones and zeros for binary strings containing more than three consecutive zeros. In HDB3, the second and third zeros of a zero string are unchanged. However, the fourth zero is transmitted with the same polarity as the preceding one (Mark). This is a violation of the bipolar AMI format. The HDB3 decoder restores a detected HDB3 pattern to the original 4 zeros.

CLOCK

XTAL - Selects the FIREBERD as the clock reference transmit timing source. This selects the interface crystal oscillator as the transmit timing source when INTF is selected from the GEN CLK menu.

RECOV - Disables the FIREBERD as the transmit timing source and recovers the clock from the incoming G.704 data as the transmit timing source when INTF is selected from the GEN CLK menu.

ERRINS

OFF - Does not insert any errors into the transmitted data.

SINGLE - Inserts single errors into the transmitted data after framing and line encoding have been performed. Inserted errors cause logic errors, code (BPV) errors, and may cause frame word errors and CRC-4 errors. If HDB3 coding is selected (from the CODE menu), error multiplication may also occur. After the error has been transmitted, the error insert menu displays **OFF**.

1E-6 - Inserts errors on the transmitted signal at the rate of 1 bit in 1,000,000.

NOTE: To ensure accurate insertion rates, the synthesizer frequency must be set to 2048 kHz. Any other setting causes inaccurate insertion rates.

3.3.5 FIREBERD 4000 Interface Remote Control

Using the built-in RS-232 interface or the optional IEEE-488 interface, the FIREBERD mainframe can be remotely controlled. The Remote Control Commands Handbook describes the mainframe remote control capabilities.

Only the remote control commands specific to this interface are included in Table 3-2. For additional information concerning remote control of the FIREBERD mainframe, refer to the FIREBERD 4000 Reference Manual (Section 4).

Table 3-2
FIREBERD 4000 G.704 2048 kb/s Data Interface Remote Commands

Remote Command	Result
INT SET	Displays the active interface
INT SEL SLOT 1	Selects the interface in slot 1
INT SEL SLOT 2	Selects the interface in slot 2
INT SET 2MG704 FRA UNFRA	Selects the unframed mode
INT SET 2MG704 FRA FRA	Selects the framed mode
INT SET 2MG704 FRA FRA CRC4 ON;TS16 ON	Selects the framed mode and enables both CRC-4 and TS-16 multiframe options
INT SET 2MG704 FRA FRA CRC OFF;TS16 OFF	Selects the framed mode and disables both CRC-4 and TS-16 multiframe options
INT SET 2MG704 TLB ON	Selects thru-loopback
INT SET 2MG704 TLB OFF	Disables thru-loopback
INT SET 2MG704 ERR INS OFF	Disables the error insert rate
INT SET 2MG704 ERR INS SIN	Selects the single error insert rate
INT SET 2MG704 ERR INS 1E-6	Sets the 1E-6 error insert rate
INT SET 2MG704 LIN TER	Selects the terminating (75- or 120-ohm) line impedance
INT SET 2MG704 LIN BRI	Selects the bridge (1000-ohm) line impedance
INT SET 2MG704 COD AMI	Sets the code standard to AMI
INT SET 2MG704 COD HDB3	Sets the code standard to HDB3
INT SET 2MG704 CLK XTA	Selects the crystal oscillator timing source
INT SET 2MG704 CLK REC	Selects the recovered timing source

The INT SET commands provide full remote control of the CCITT G.704 2048 kb/s Framing Interface. INT SET displays but does not change the currently active interface in the FIREBERD mainframe. The INT SEL 2MG704 command makes the installed CCITT G.704 2048 kb/s Framing Interface the active interface.

INTERFACE SPECIFICATIONS

4.1 INTRODUCTION

This section contains the specifications for the CCITT G.704 2048 kb/s Framing Interface. This information is listed in Table 4-1.

Table 4-1
CCITT G.704 2048 kb/s Framing Interface Specifications

Item	Specification
General	
Operating Rate:	2048 kb/s typical, ±1.0 kb/s.
Coding:	HDB3 (CCITT G.703 Annex A). AMI (Alternate Mark Inversion).
Connectors:	120-ohm balanced: 4 mm banana jack. 75-ohm unbalanced: BNC.
Receiver	
Impedance:	Balanced: 120 ohms. Unbalanced: 75 ohms. Tolerance: ±8.5%.
Return Loss:	Greater than or equal to 20 dB from 40 kHz to 2500 kHz.
Minimum Operating Level: (Input level relative to typical pulse)	Cable: -9 dB. Resistive: -9dB.
Framing Structure:	CCITT G.704 with CRC-4 compatibility.
Earth Connection:	Receive cable shield may optionally be connected to local earth ground.

Table 4-1
CCITT G.704 2048 kb/s Framing Interface Specifications

Item	Specification
Transmitter:	
Pulse Shape:	Conforms to Figure 15 of CCITT Recommendation G.703.
Pulse Level:	120 ohm: 3V, ±10%. 75 ohm: 2.37V, ±10%.
Pulse Width:	244 ns ±25 ns.
Ratio of + and - Pulse Widths:	0.95 to 1.05.
Space Voltage:	120 ohm: 0±0.3V. 75 ohm: 0±0.237V.
Frame Structure:	CCITT G.704 with CRC-4 compatibility.
Earth Connection:	BNC cable shield connected to local earth ground.
Crystal Oscillator:	Frequency: 2048 kHz. Tolerance: ±5 ppm (0 to 50°C). Drift: ±1 ppm per year.

MAINTENANCE AND SERVICE

5.1 INTRODUCTION

This section contains information on maintenance and service for the CCITT G.703 2048 kb/s Framing Interface, including TTC's warranty policies and repair procedures.

5.2 MAINTENANCE

5.2.1 In Case of Difficulty

If the FIREBERD mainframe totally fails to operate after installing the interface, (i.e., no panel indicators light), check the following items:

- Verify that the supply line voltage is present.
- Verify that the AC line cord is supplying the line voltage to the mainframe.
- On the FIREBERD mainframe, verify the proper line voltage selection.
- On the FIREBERD mainframe, verify the fuse is not blown and that it is correct for the supplied line voltage.
- Verify the interface is properly seated into the mainframe.

If some of the indicators light but the unit fails to operate, verify that the interface installed is the correct type and that it is properly installed. Be sure to turn the power off before trying to remove or reseat the interface. If another interface module is available, turn off the power and substitute the other interface.

If troubles still persist, follow the self-test procedures in the FIREBERD Operating Manual as an aid in localizing the problem. If the mainframe continues to be inoperative, refer to the following sections for service information, or call the TTC Customer Service Department for assistance.

5.3 SERVICE

5.3.1 Warranty Policy

All equipment manufactured by Telecommunications Techniques Corporation (TTC) is warranted against defects in material and workmanship. This warranty applies only to the original purchaser and is non-transferable unless express written authorization of the warranty transfer is granted by TTC.

Data interfaces, accessories, cables, breakout boxes, and all equipment (other than FIREBERD mainframes) will be repaired or replaced (at our option), at no charge, for a period of one (1) year after shipment to the customer.

Liability under this warranty extends only to the replacement value of the equipment. This warranty is void if:

(1) Equipment has been altered or repaired without specific written authorization from TTC.

(2) Equipment is installed or operated other than in accordance with instructions contained in TTC literature and operating manuals.

No other warranty is expressed or implied. TTC is not liable for consequential damages.

5.3.2 In-Warranty Service

Equipment in warranty must be returned to the factory with shipping prepaid. The equipment should be packed and shipped in accordance with the instructions in Section 5.3.4 of this manual. Before returning any equipment, the customer must obtain a Return Authorization (RA) number by contacting the TTC Repair Department. The RA number should be included on all paperwork and be clearly marked on the outside of the shipping container.

After the equipment is repaired by TTC, it will be tested to applicable specifications, burned-in for at least 24 hours, retested, and returned to the customer with shipping prepaid.

A brief description of the work performed and the materials used will be provided on the Equipment Repair Report that will be furnished with the returned equipment.

5.3.3 Out-of-Warranty Service

The procedure for repairing out-of-warranty equipment is the same as that used for equipment still in warranty. However, there is a minimum charge applied to each request for out-of-warranty service. The minimum charge guarantees the customer an estimate of the repair costs and is used as credit against actual materials and labor costs should the equipment be repaired. Contact the TTC Repair Department for specific information on the minimum out-of-warranty repair charge.

The customer will be billed for parts and standard labor rates in effect at the time of repair. The customer will also be required to furnish a purchase order number before repair work can be started. A hard copy of the purchase order must be received by TTC before the repaired equipment can be shipped to the customer. A description of the materials used will be provided in the Equipment Repair Report.

Once an out-of-warranty repair is made, the repaired part or component is warranted for 90 days. This warranty applies only to the part or component that was repaired; other parts or components are not covered under the 90-day repair warranty.

5.3.4 Equipment Return Instructions

To all equipment returned for repair, the customer should attach a tag that includes the following information.

(1) Owner's name and address.

(2) A list of equipment being returned and the corresponding serial number(s).

(3) A detailed description of the problem or of the service requested.

(4) The name and telephone number of the person to contact regarding questions concerning the repair(s).

(5) The Return Authorization (RA) number.

If possible, the customer should return the equipment in the original shipping container and material. If the original container is not available, the unit should be carefully packaged so that it will not be damaged in transit. TTC is not liable for any damage that occurs during shipment. The customer should clearly mark the TTC-issued RA number on the outside of the package and ship it prepaid and insured to TTC.

APPENDIX A

Table A-1
Revision F Remote Control Commands

The FIREBERD 6000 remote control commands supported by Revision F software or lower are as follows:

Remote Command	Result
INT SET	Displays the active interface
INT SET 2MG704	Selects the CCITT G.704 2048 kb/s Framing Interface as the active interface
INT SET 2MG704 FRA UNFRA	Selects the unframed mode
INT SET 2MG704 FRA FRA	Selects the framed mode
INT SET 2MG704 FRA FRA CRC4 ON;TS16 ON	Selects the framed mode and enables both CRC-4 and TS-16 multiframe options
INT SET 2MG704 FRA FRA CRC OFF;TS16 OFF	Selects the framed mode and disables both CRC-4 and TS-16 multiframe options
INT SET 2MG704 RES STD	Selects the standard results criteria
INT SET 2MG704 RES LIV	Selects the live results criteria
INT SET 2MG704 TLB ON	Selects thru-loopback
INT SET 2MG704 TLB OFF	Disables thru-loopback
INT SET 2MG704 ERR INS OFF	Disables the error insert rate
INT SET 2MG704 ERR INS SIN	Selects the single error insert rate
INT SET 2MG704 ERR INS RAT xE-y	Sets the error insert rate where x = 1-9 and y = 3-9
INT SET 2MG704 LIN TER	Selects the terminating (75- or 120-ohm) line impedance
INT SET 2MG704 LIN BRI	Selects the bridge (1000-ohm) line impedance
INT SET 2MG704 COD AMI	Sets the code standard to AMI
INT SET 2MG704 COD HDB3	Sets the code standard to HDB3
INT SET 2MG704 CLK XTAL	Selects the crystal timing source
INT SET 2MG704 CLK REC	Selects the recovered timing source

The INT SET commands provide full remote control of the CCITT G.704 2048 kb/s Framing Interface. INT SET displays but does not change the currently active interface in the FIREBERD mainframe. The INT SET 2MG704 command makes the CCITT G.704 2048 kb/s Framing Interface the active interface.

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